January 28, 1836.

RODERICK IMPEY MURCHISON, Esq., V.P., in the Chair.

William Clark, M.D.; and Francis Marcet, Esq., were elected Fellows of the Society.

A paper was read, entitled, "Discussion of Tide Observations made at Liverpool." By J. W. Lubbock, Esq., F.R.S.

The chief purpose which the author has in view in presenting the tables accompanying this paper, which are a continuation of those published in the Philosophical Transactions for 1835, and are founded on the observations instituted by Mr. Hutchinson at Liverpool, is to exhibit the diurnal inequality in the height of high water, which is scarcely sensible in the river Thames, but which at Liverpool amounts to more than a foot. The diurnal inequality in the interval appears to be insensible.

The author has farther ascertained that Bernouilli's formulæ expressing the height of the tide, deduced from his theory of the tides, present a very remarkable accordance with observation.

February 4, 1836.

SIR JOHN RENNIE, Knt., Vice-President, in the Chair.

George William Drory, Esq.; Robert Edmund Grant, M.D.; and John Dillwyn Llewelyn, Esq.; were elected Fellows of the Society.

"Geometrical investigations concerning the Phænomena of Terrestrial Magnetism: Second Series,—On the number of points at which a magnetic needle can take a position vertical to the Earth's surface." By Thomas Stephens Davies, Esq., F.R.S. Lond. and Edin., F.R.A.S., of the Royal Military Academy, Woolwich.

This paper is intended as a continuation of the one by the same author published in the last volume of the Philosophical Transactions; in which it was proposed to investigate the mathematical consequences of the hypothesis of the earth being a magnet with two poles, or centres of force, situated anywhere either within, or at the surface, and of equal intensity, but of contrary characters: with the ultimate view of verifying this hypothesis by comparing its results, so deduced, with the phænomena furnished by observation.

In his former paper the author had shown that on this hypothesis the magnetic equator, or the locus of the points at which the magnetic needle takes a horizontal position, is one single and continuous line on the surface of the earth. In this paper his object is to prove that there are always two, and never more than two, points at the earth's surface, at which the needle takes a position vertical to the horizon.

At the close of his former paper the author had deduced the equation of the curve of verticity, that is, of the curve at any point

of which an infinitesimal needle being placed, it will always tend towards the centre of the earth, and consequently be vertical to the horizon at its point of intersection with the surface of the earth: but, owing to circumstances over which he had no control, he was unable, at that time, to write out an account of his investigations of the peculiar character of that curve, or to apply its properties to the determination of the latter problem: and these are more especially the objects to which the present paper is devoted.

The processes to which he has had recourse, with this view, are the following. He first transposes the rectangular equation of the curve into a polar equation, and finds that in the result the radius vector is involved only in the second degree; and hence that for every value of the polar angle there are two values of the radius vector, and never more than two; or, in other words, that no line drawn from the centre of the earth can cut the curve of verticity in more than two points. But as no means present themselves of ascertaining whether the values of (r), the polar ordinates of the curve of contact, be always real or not, or how many values of ($\theta_{,}$), the other co-ordinate to that curve, are possible for any given value of r; he abandons this method of inquiry, contenting himself with a few deductions respecting the general form of the locus, and proceeds to employ a different method.

The general system of his reasonings proceeds on the principle that as the magnetic curve itself, and the curve of verticity have one common and dependent genesis, a knowledge of the properties of the former must throw considerable light on those of the latter; and he is accordingly induced to enter into a more minute examination of the magnetic curve than had before been attempted. As both the polar and the rectangular equations of this curve are much too complex to afford any hope of success in their investigation, the author has recourse to a system of co-ordinates, which he terms the "*angular system*," and which was suggested to him originally by the form under which Professor Playfair exhibited this equation in Robison's Mechanical Philosophy. But as he has not yet published his investigations of the differential coefficients, and other formulæ necessary in the application of this system, he puts his results in a form adapted to rectangular co-ordinates; each rectangular co-ordinate being expressed in terms of his angular co-ordinates and the constants of the given equation; and by these means deduces the characters of the magnetic curve throughout its whole course.

The angular equation being

$$\cos\theta_{,} \times \cos\theta_{,,} = 2\cos\beta,$$

he finds, 1°, that the two equations, the convergent and the divergent, or that in which the poles are unlike, and that in which they are like, are both expressed by this equation, and essentially included in it: 2°, that the divergent branches on one side of the magnetic axis are algebraically and geometrically continuous with the convergent branches on the other side; the parameter (β) being the same in both cases: 3°, that the divergent branches are assymptotic, and the assymptote is capable of a very simple construction;

4°, that the continuous branches have the poles as points of inflexion, and that these are the only points of inflexion within finite limits: 5°, that a tangent at any point of the curve, or, which is the same thing, the direction taken by a small needle placed there, admits of easy construction: 6°, that when the parameter (β) is such as to cause the convergent and divergent branches to intersect, they do so in a perpendicular to the magnetic axis drawn from the poles: 7°, that the convergent branches are always concave, and the divergent always convex, to a line at right angles to the magnet, drawn from its middle,—besides other properties not less interesting, though less capable of succinct enunciation.

Having separated the branches belonging to the case of like poles from those belonging to the unlike ones in the magnetic curve, the author proceeds to a similar separation of the corresponding branches in the curve of verticity. In the former case the curve is composed of four branches infinite in length, having the magnetic axis for assymptotes, lying above that axis, and emanating from the poles to the right and left; and of two finite branches, continuous with those just described, and lying below the magnetic axis; one of which passes through the centre of the earth, and meets the other in the perpendicular from the middle of the axis; so that the whole system is constituted by one continuous curve, extending from negative infinite to positive infinite, and having the lines drawn from the centre of the earth to the magnetic poles as tangents at the poles; and no part of the curve lies between these tangents. It bears in form some general resemblance to a distorted conchoid; this curve not having either cusp or loop. In the second case, the curve is also composed of four branches, two finite and two infinite ones; the latter having the line drawn from the centre of the earth through the middle of the magnet as assymptotes, and both lying on the same side of it as the more distant pole; and the finite branches joining these continuously at the poles, and each other in the middle of the magnetic axis; the one from the nearer pole lying above the axis, and the one from the remoter pole lying below it. The branches, where they unite at the poles, have the lines drawn from the centre of the earth to the poles as tangents, and the lower infinite branch passes through the centre. The whole system of branches is comprised between the polar tangents; and the two systems are mutually tangential at the poles, and intersect each other at the centre; but they have no other point in common.

Lastly, the author proceeds to demonstrate that a circle (namely, the magnetic meridian) described from the centre of the curve of verticity, will always cut the convergent system in two points, but can never cut it in more than two. He remarks, however, that if we could conceive two poles of like kinds to exist without any other whatsoever, we might have either four points of verticity, or only two, according to circumstances; but he waves the discussion of this particular case, as being irrelevant to the purpose of his present inquiry.

Mr. Davies announces his intention of shortly laying before the

Society a continuation of these researches; devoting the next series to the points of maximum intensity.

"Memoir on the Metamorphoses in the *Macroura*, or Long-tailed Crustacea, exemplified in the Prawn (*Palæmon serratus*)." By John V. Thompson, Esq., F.L.S., Deputy Inspector-General of Hospitals. Communicated by Sir James Macgrigor, M.D., F.R.S., &c.

The author gives descriptions, illustrated by outline figures, of three different stages of growth of the Prawn; the first being that of the larva immediately on its exclusion from the egg; the second, at a later period, when it has acquired an additional pair of cleft members, and a pair of scales on each side of the tail; and the third, at a still more advanced stage of development, when it presents the general appearance of the adult Prawn, but still retains the natatory division of the members, now increased to six pair. The author thinks it probable that an intermediate stage of metamorphosis exists between the two last of these observed conditions of the animal.

February 11, 1836.

DAVIES GILBERT, Esq., Vice-President, in the Chair.

David Baillie, Esq., and Dr. Archibald Robertson, were elected Fellows of the Society.

A paper was in part read, entitled, "On Voltaic Combinations." In a letter addressed to Michael Faraday, Esq., D.C.L., F.R.S. Fullerian Professor of Chemistry in the Royal Institution of Great Britain, &c., &c. By John Frederick Daniell, Esq., F.R.S., Professor of Chemistry in King's College, London.

February 18, 1826.

FRANCIS BAILY, Esq., Vice-President and Treasurer, in the Chair.

John Green Cross, Esq., was elected a Fellow of the Society.

The reading of Mr. Daniell's paper, entitled, "On Voltaic Combinations," in a letter to Michael Faraday, Esq., D.C.L, F.R.S., &c., was resumed and concluded.

The author, after expressing his obligations to Mr. Faraday for the important light which his late researches in electricity have thrown on chemical science, proceeds to state that in pursuing the train of inquiry which has thus been opened, he has obtained further confirmations of the truth of that great principle discovered and established by Mr. Faraday, namely, the definite chemical action of electricity; and has thence been led to the construction of a voltaic arrangement which furnishes a constant current of electricity for any required length of time.

For the purpose of ascertaining the influence exerted by the different parts of the voltaic battery in their various forms of combi-